0001, 0002, 0020, 0004, 0005

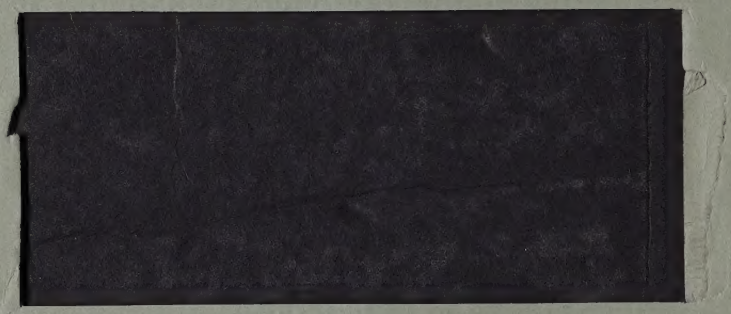
INSTRUCTIONS

FOR

DANA* DIGITAL ACCESSORIES

DANA

RECEIVED
FEB 18 1964
METROLOGY



*Trademark

Publication No. DL - 227

INSTRUCTIONS

FOR

DANA* DIGITAL ACCESSORIES

DANA LABORATORIES, INC
630 East Young Street
Santa Ana, California

Telephone: (714) 546-1130
TWX: (714) 546-2238

TABLE OF CONTENTS

Preamplifier 1.0

Ohms Converter 2.0

AC Converter 3.0

Filter 4.0

SCHEMATICS:

Preamplifier Schematic 5.0

Ohms Converter Schematic 6.0

AC Converter Schematic 7.0

Filter Schematic 8.0

INSTRUCTIONS

FOR

DC PREAMPLIFIER

MODEL 0001

INTRODUCTION

The Dana Model 0001 DC Preamplifier is a signal conditioning plug-in circuit card for use with Dana Series 5000 or 4000 Digital Voltmeters (DVM's).

When inserted in a DVM which is properly wired, it allows millivolt signals to be measured with the normal voltmeter leads. The 0001 is contained within and derives its power supply voltages from the DVM. The guarded input characteristics of the Dana DVM are retained for millivolt measurements. Full one digit resolution is maintained when the preamplifier is used.

PRELIMINARY SPECIFICATIONS

Model 0001 - D.C. Preamplifier

Function	Amplifies very small DC signals to increase the sensitivity of the DVM; all specifications refer to DVM output as a function of input voltage
Ranges	± 10; ± 100; ± 1000 millivolts full scale
Resolution on Most Sensitive Range	0.1 microvolt per digit (Series 5000 DVM) 1.0 microvolt per digit (Series 4000 DVM)
Accuracy	0.02% of reading or 0.01% of full scale of range, with zero adjustment set correctly
Zero Stability	± 5 microvolts for one year
Input Resistance	100 megohms minimum, all ranges
Range Control	Automatic with manual override, selected by DVM front panel knob
Decimal Point Indication	Automatic; displayed in millivolts
Function Control	Preamplifier is inserted between signal and DVM by selecting "millivolt" position of function selector
Measuring Time	DC voltage measuring time plus 1 second on fixed range and polarity; DC measuring time plus 3 seconds worst case polarity and range change
Isolation	Preamplifier input is isolated and guarded from ground, AC power line and electrical output

Preliminary Specifications, continued

Size and Mounting	Preamplifier is wholly enclosed within Dana series 4000/5000 DVM; there are no additional cables, connectors, or controls

DESCRIPTION

The Dana Model 0001 DC preamplifier is a standard accessory for use with Dana 4000 or 5000 Series DVM's. Solid state circuitry is used throughout and a precision mechanical modulator assures low drift characteristics. The three automatic or manually selected ranges are factory set for maximum accuracy and long term stability is assured by the use of premium, highly stable feedback resistors. No periodic field adjustments are required.

All circuitry is contained on a single printed circuit card that can be conveniently inserted into its prewired position in the DVM and placed in operation immediately. No preliminary adjustments are required. (Some DVM's manufactured prior to this manual were not prewired for accessories.)

OPERATION

When the Model 0001 is installed in a Dana DVM, millivolt measuring capability is available using the normal input leads. Operation of the DVM for millivolt measurements is much the same as for standard DC measurements, since the normal guarded input circuit, and all automatic features are available.

To activate the preamplifier, the function switch is placed in the "Millivolt" position. Automatic ranging may then be selected as in standard DC operation, or if desired, the instrument may be manually placed on the 10, 100, or 1000 millivolt position. The 1 millivolt range is not operational and should not be used as this position of the range switch is used only with AC Converters and Ohms Converters. It is also a valid position for the 4000 Series DVM's when the selected function is "DC Volts" or "Ratio x 10".

Any of the standard mode positions may be selected when measuring millivolts; however, they will react, or in some cases appear to react, somewhat differently. These differences are described below.

Periodic- When polarity and range changes are not required, operation will be normal and periodic measurements will be made at the repetition rate determined by the specific DVM is use; however, when a range or polarity change occurs, the "time out" circuits in the DVM (set for approximately 1.0 seconds in "Millivolt" function) will inhibit read commands to permit the preamplifier to settle and avoid erroneous readings.

Command- Operation is normal but sampling will not necessarily commence immediately if ranging or polarity changes are required. (Refer to above time delays.)

Auto Threshold- Operation is identical to standard DC operation.

Manual Threshold- Operation is normal but due to the extreme sensitivity of the system, the operator may find it necessary to increase the threshold level more often than on standard DC measurements.

The preamplifier is factory adjusted for minimum offset. However, the operator may wish to readjust the zero control occasionally to compensate for thermal potentials generated in a given test setup. The zero control is located on the front of the Preamplifier, readily accessible behind the right front panel section. The card is located in card position number 26 (second card position from extreme right). The adjustment should be made only after the DVM and all associated input circuits have achieved thermal stability. To illustrate the importance of the latter, set the DVM to the 10 millivolt range and short the input probes. After the instrument has arrived at a balanced condition, take hold of the test probes and observe the change in reading as the test probes heat.

The Model 0001 was designed for on-the-line applications, and therefore is as foolproof as is consistent with performance requirements. Fusing being impractical due to thermal problems, the instrument was designed to withstand sustained overloads up to 10 volts. Although higher voltages can be tolerated for short periods of time, the operator should exercise care to see that the 10 volt rating is not exceeded.

INSTRUCTIONS

FOR

OHMS CONVERTER

MODEL 0002

INTRODUCTION

The Dana Model 0002 Ohms Converter is a signal conditioning plug-in circuit card for use with Dana Series 4000 or 5000 Digital Voltmeters (DVM's). When installed in a DVM which is properly wired, it allows resistance (in kilohms) to be measured with 4 leads. The 0002 is contained within and derives its power supply voltages from the DVM.

SPECIFICATIONS

Model 0002 - Ohms Converter

Function	Converts DC resistance into proportional DC voltage, which is measured by DVM. Specifications refer to DVM output as a function of input resistance
Maximum Resistance	999.99 Kilohms, Series 5000 DVM 1099.9 Kilohms, Series 4000 DVM
Resolution	0.01 ohm, Series 5000 DVM; 0.1 ohm, Series 4000 DVM
Ranges	1; 10; 100; 1000 kilohms full scale
Accuracy	0.01% of reading and 1 digit except on 1000 K ohm range; 0.03% of reading and 1 digit on 1000 K ohm range
Note:	Series 5000: 1 digit = 0.001 of full scale of range; Series 4000: 1 digit = 0.01% of full scale of range
Range Control	Automatic with manual override, selected by knob on DVM front panel
Decimal Point Indication	Automatic in kilohms; ohms function selected by setting knob on DVM front panel to "kilohms"
Measuring Time	DC measuring time plus 200 milliseconds for single range; DC measuring time plus 500 milliseconds worst case with automatic range
Voltage Across Unknown	Approximately 10 volts at full scale proportionally less at less than full scale (open circuit voltage, 15 v); maximum current limited to 10 milliamperes on 1 K range.
Size and Mounting	Ohm converter is wholly enclosed in Dana Series 5000/4000 Digital Voltmeter case; there are no additional controls or connectors

DESCRIPTION

The Model 0020 Ohms Converter is an all solid state circuit card that accepts a resistance input and converts it to a DC voltage which is measured by the DVM. When used in a Dana Series 4000 or 5000, highly precise resistance measuring capability is provided with automatic range selection.

The converter is essentially an operational amplifier. A precise range resistor determines the input current to the summing junction of the amplifier and the unknown resistor is the feedback resistor. One pair of leads to the unknown provides a current path while a second pair of leads senses the voltage across the unknown with negligible current flow.

Output voltage of the converter equals $V_{in} \frac{Rx}{Rr}$ where R_x = Unknown resistor
R_r = Precise range resistor

V_{in} is applied internally to the reference input of the DVM so that the DVM readout is completely determined by the ratio $\frac{Rx}{Rr}$. The value of R_r is determined by the range switch, which also positions the decimal point on the readout.

Protective features virtually eliminate the possibility of damage to the converter by inadvertent misuse. If the DVM function switch is not in "kilohms", the converter is disconnected by open relays. If voltage is applied when in "kilohms", the input is protected by a diode limiter and the output is protected by a replaceable fuse.

OPERATION

General

A Dana Digital Voltmeter equipped with the Dana Model 0002 Ohms Converter makes high accuracy digital resistance measurements possible.

The Model 0002 Converter utilizes the Kelvin four-terminal method of measurement. It consists of passing a known current through the unknown resistor and measuring the potential drop across it with a high precision digital voltmeter. This basic method of resistance measurement was developed by Lord Kelvin many years ago, and is one of the most reliable and precise methods developed in which the lead and contact resistances can be balanced out.

The input cable to the instrument consists of six different leads and it is IMPORTANT that the user understand the functions of each lead and connect them properly.

OHMMETER LEAD FUNCTIONS

Current +	Delivers current (limited to 10 ma maximum at 1 K)
Current -	Accepts current
Sense +	Senses Voltage
Sense -	Senses Voltage
Guard	Is connected to the floating shield (if any) of device being measured. Do not connect to unknown or ground
Ext. Ref. 11V Max	Is not used in resistance measurements.

HOOK UP PROCEDURE (See Figures 1, 2, and 3)

1. Connect "Sense +" lead (Large Red Clip) to side of unknown nearest ground.

2. Connect "Current +" lead (Small Red Hood) to same side of unknown, outside "Sense +" lead.

3. Connect "Sense -" lead (large black clip) to opposite side of unknown.

4. Connect "Current -" lead (small black hood) to same side as "Sense -", outside "Sense -".

5. Connect "Guard" lead (small black hood) to floating shield around unknown, if shielded. Do not connect to Unknown. Do not use if unknown doesn't have floating shield.

6. DO NOT USE "Ext. Ref." lead (small white hood).

7. Switch DVM Function Switch to "Kilohms".

8. If reading is noisy, shunt Unknown Resistor with a .01 mfd Polystyrene or high quality Mylar capacitor. (A .01 mfd capacitor connected internally should filter noise in most applications without additional filtering).

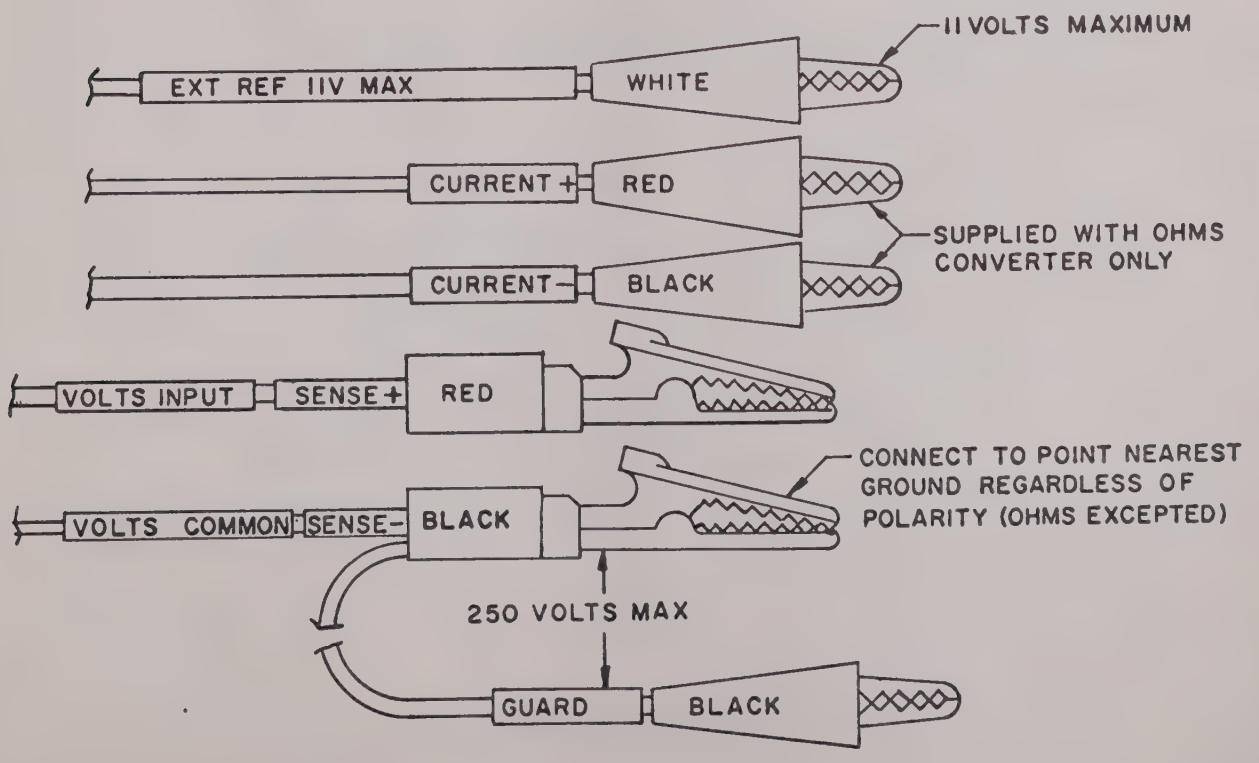


FIGURE 1 - DVM Input Cable

CAUTION

In precision resistance measurements, especially in the high resistance area, the effect of surface resistance, humidity and external noise can cause errors. It is recommended that the user employ extreme caution including proper shield and guarding, if possible, to prevent this type of error.

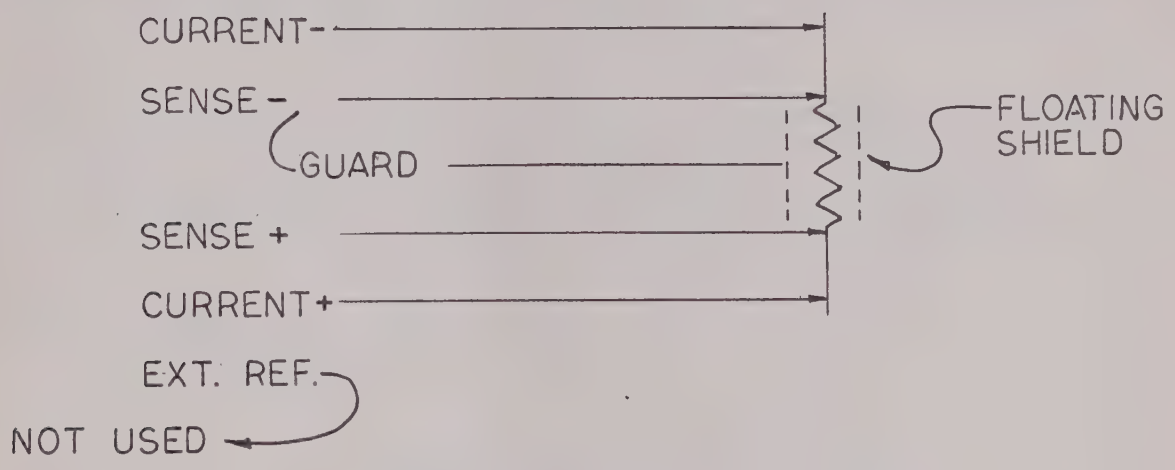


FIGURE 2 - MEASUREMENT OF FLOATING RESISTOR

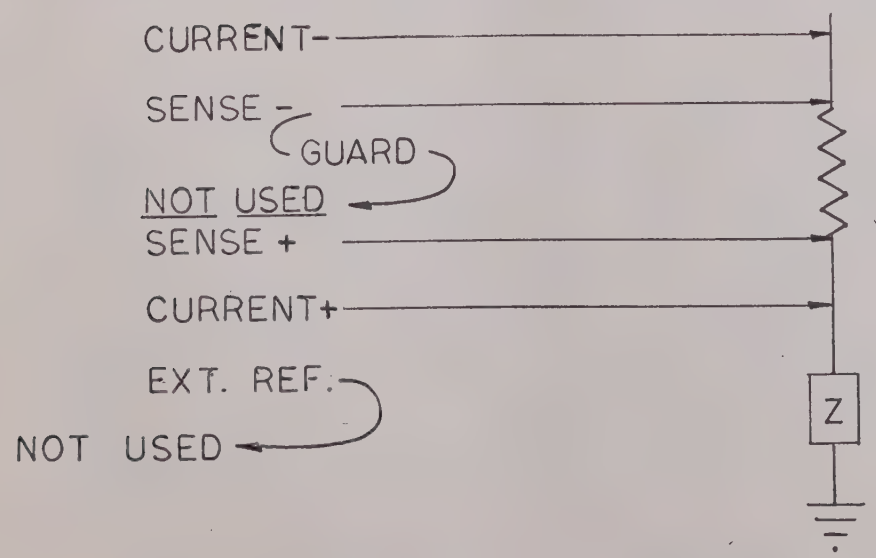


FIGURE 3 - MEASUREMENT OF RESISTOR TIED TO GROUND

CALIBRATION PROCEDURE

When shipped from the factory, the Model 0002 is carefully calibrated well within specifications. Calibration adjustments in the field should not be required for at least 6 months (unless input cable is changed). Calibration should not be attempted unless accurate standards are available to verify the need for calibration and to make the calibration itself.

This procedure describes two techniques for the calibration of the Ohms to DC Converter. Either procedure will provide quantitative information and data for its certification to the Manufacturers specifications. It is recommended that the Standards Laboratory technique of calibration be used periodically since this will establish a "confidence level" over a long period of time.

FIELD CALIBRATION: (See Figures 2 and 4

Equipment Required:

* 1 - 1 Megohm resistor, known or certified to better than ± 0.01%.
* 1 - 100,000. ohm resistor, known or certified to better than ± 0.01%.
* 1 - 10,000. ohm resistor, known or certified to better than ± 0.01%.
* 1 - 1,000. ohm resistor, known or certified to better than ± 0.01%.

*It is necessary that the certified value of the above resistor be slightly less than the exact values indicated above. This will permit the 5 digit DVM to be calibrated on each of the various ranges without overranging. For instance, a 999.95 ohm resistor could be read on the 1 K range of the 5 digit DVM, while a 1000.5 ohm resistor would have to be measured on the 10 K range. On a 4 digit meter, overranging is provided. If the proper values are not available, series/parallel combinations of standard resistors may be used. Select combinations that will permit the various ranges to be calibrated near full scale. The temperature coefficient in parts per million per degree centigrade should be known. This is especially important where wide temperature gradients exist. Corrections in ppm/per degree centigrade should be applied where such conditions exist.

1.0 Turn on the DVM and allow at least one-half hour warm-up time.

1.1 Select the 100K standard resistor and connect as shown in Figure 2. (Page 4.3)
Note: The black "Sense -" and the black "Current -" leads are connected to one end of the resistor and the red "Current +" and the red "Sense +" leads are connected to the other end of the resistor. It is usually necessary to shield the 100 K resistor, in which case the guard would be connected to the shield.

1.2 Set the mode switch to the Periodic position.

1.3 Set the function switch to the Ohms position.

1.4 Set the range switch to the 100 K position.

1.5 Adjust the 100 K calibration potentiometer on the Ohms Converter card, (third trimpot from bottom) to agree with the certified value of the standard resistor. (See Figure 4.)

1.6 Next install the 1 megohm standard resistor in place of the 100 K standard, set the range switch to the 1,000 K position, and adjust the 1 megohm calibration potentiometer on the Ohms Converter card, (fourth trimpot from bottom) to agree with the certified value of the standard resistor.

1.7 Next install the 10,000 ohm standard resistor in place of the 1 megohm standard, set the range switch to the 10 K position, and adjust the 10 K calibration potentiometer on the Ohms Converter card, (second trimpot from bottom) to agree with the certified value of the standard resistor.

1.8 Next install the 1,000 ohm standard resistor in place of the 10,000 ohm standard, set the range switch to the 1 K position, and adjust the 1 K calibration potentiometer on the Ohms Converter card, (bottom trimpot) to agree with the certified value of the standard resistor.

Notes: Since there is some interaction between the various calibration adjustments, it is important that the ranges be calibrated in the order shown. Do not attempt to adjust either the "Voltage Zero" or "Current Zero" trimpots in the field. These adjustments must be made with a Null Galvanometer and are best done in the Standards Laboratory.

This completes the Field Calibration Procedure.

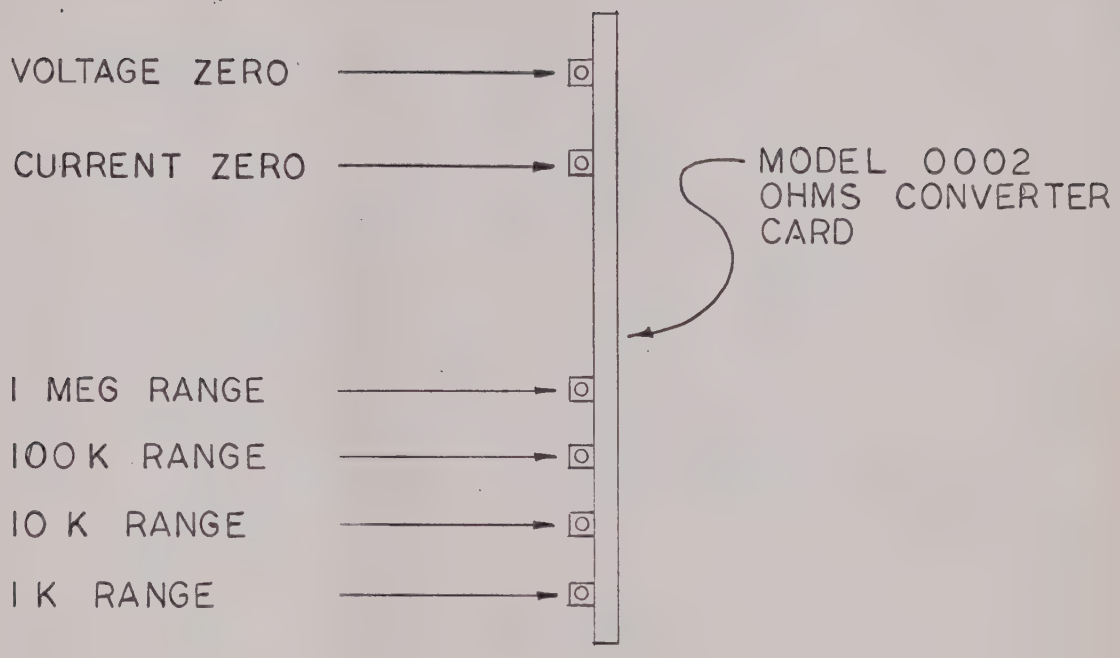


FIGURE 4 - OHMS CONVERTER ADJUSTMENTS

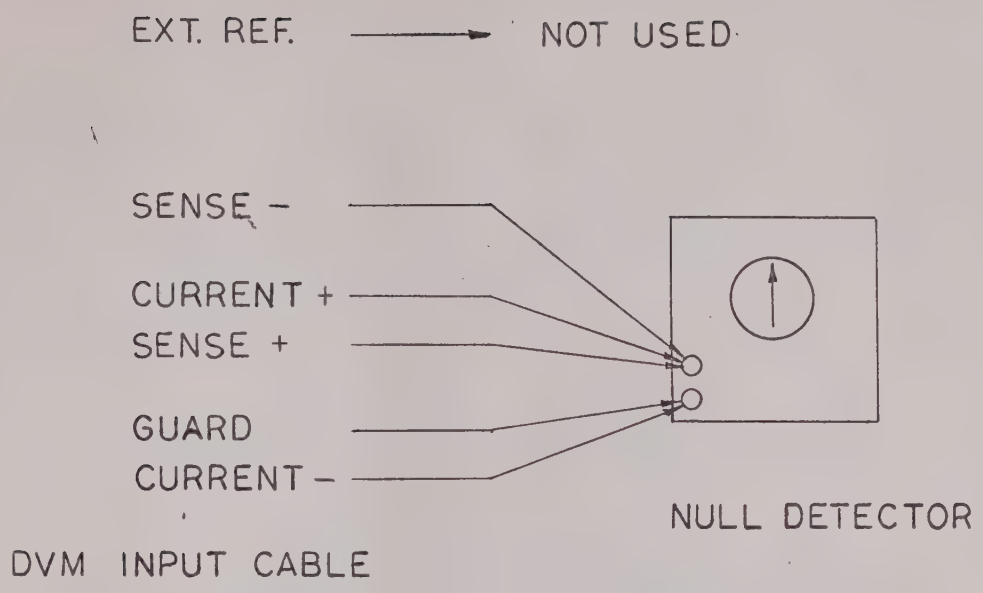


FIGURE 5 - Standards Laboratory Adjustment of Voltage Zero

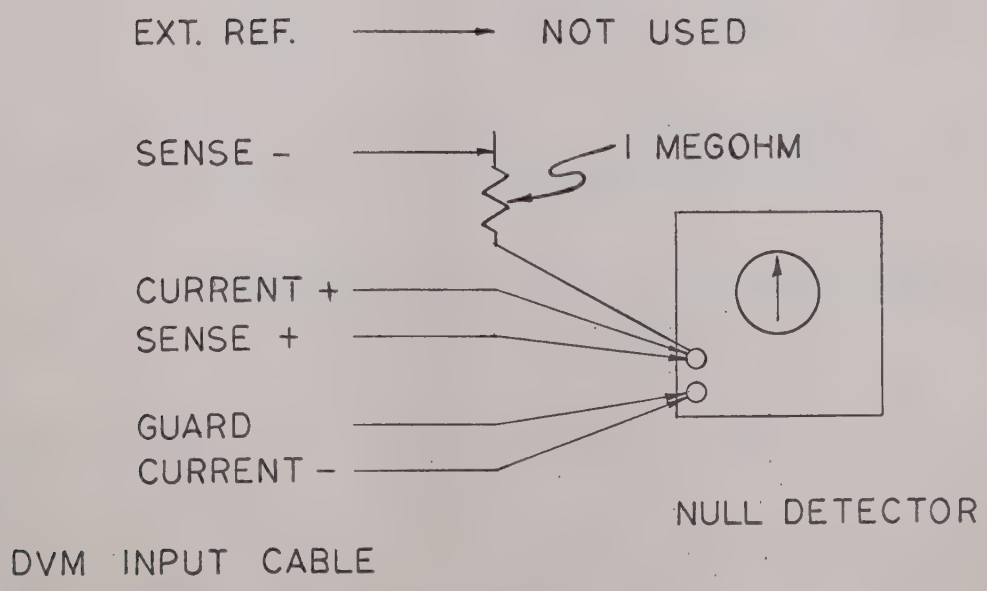


FIGURE 6 - Standards Laboratory Adjustment of Current Zero

STANDARDS LABORATORY CALIBRATION PROCEDURE: (See Figures 4, 5, and 6)

The technique for Standards Laboratory calibration of the Dana 0002 Ohms to DC Converter is that used by the factory. It is designed to provide the user with the highest accuracy possible using Laboratory standards.

Equipment Required:

1 - 1,000,000.0 ohm standard resistor, known or certified to ± 0.005% or better with T/C of 10 ppm or less. L & N 4020 NBS series.

1 - 100,000.0 ohm standard resistor, known or certified to ± 0.005% or better with T/C of 10 ppm or less. L & N 4020 NBS series.

1 - 10,000.0 ohm standard resistor, known or certified to ± 0.005% or better with T/C of 10 ppm or less. L & N 4020 NBS series.

1 - 1,000.0 ohm standard resistor, known or certified to ± 0.005% or better with T/C of 10 ppm or less. L & N 4020 NBS series.

1 - Guarded DC electronic null detector. L & N Model 9834 or equivalent.

2.0 In standards laboratories equipped for close temperature control, it is recommended that the DVM be "temperature soaked" in an operating condition for at least two hours prior to calibration.

2.1 Connect the null detector as shown in Figure 5. ("Guard" is galvo common, red "Sense +" / "Volts Input" lead is galvo + input). Set the DVM on the 1,000K range.

2.2 Short the red "Sense +", red "Current +", and black "Sense -" leads together. Connect the "Current -" and the Guard to galvo common. The "Ext Ref" lead is left unconnected.

2.3 Zero or null the DVM as indicated on the null detector by adjusting the Voltage Zero (top trimpot) on the Ohms to DC Converter card. This zero or null should be less than 20 microvolts.

2.4 Next, connect the 1 megohm standard resistor as shown in Figure 6. The "Ext Ref" 11V Max lead is left unconnected.

2.5 Zero or null the DVM as indicated on the Null Detector by adjusting the Current Zero (second trimpot from the top) on the Ohms to DC Converter card. This zero or null can be adjusted to approximately 25 microvolts or less (noise level of this approximate level is normal).

2.6 Use the 100K ohm standard resistor and set the controls as follows:

Mode switch to the "Periodic" position.
Function switch to the "Ohms" position.
Range switch to the 100K position.
Threshold potentiometer to full clockwise position.
Connect the black "Sense-" lead to one potential terminal on the NBS standard resistor. Connect the black "Current-" lead to the adjacent current terminal on the NBS standard resistor.
Connect the red "Current +" lead to the other current terminal on the NBS standard resistor.
Connect the red "Sense +" lead to the other potential terminal on the NBS standard resistor.
It is usually necessary to place the test resistor in a floating shield in which case, the Guard will be connected to the shield. The "Ext Ref" lead is not used.

2.7 Adjust the 100K calibration potentiometer on the Ohms to DC Converter card (third trimpot from bottom) to agree with the certified value of the standard resistor.

2.8 Replace the 100K standard resistor with the 1 megohm standard, set the range switch to the 1,000K position, and adjust the 1 megohm calibration potentiometer on the Ohms to DC Converter card (fourth trimpot from bottom) to agree with the certified value of the standard resistor.

2.9 Replace the 1 megohm standard resistor with the 10,000. ohm standard, set the range switch to the 10K position, and adjust the 10K calibration potentiometer on the Ohms to DC Converter card (second trimpot from bottom) to agree with the certified value of the standard resistor.

3.0 Replace the 10,000. ohm standard resistor with the 1,000. ohm standard, set the range switch to 1K position, and adjust the 1K calibration potentiometer on the Ohms to DC Converter card (bottom trimpot) to agree with the certified value of the standard resistor.

3.1 This completes the calibration. If desired and required, intermediate values of resistances by means of series/parallel combinations of standard resistors may be measured and recorded.

Note: Since there is some interaction between the various calibration adjustments, it is important that the ranges be calibrated in the order shown.

INSTRUCTIONS

FOR

AC CONVERTER

MODEL 0020

INTRODUCTION

The Dana Model 0020 AC Converter is a signal conditioning plug-in circuit card for use with Dana Series 4000 or 5000 Digital Voltmeters (DVM's). When installed in a DVM which is properly wired, it allows AC voltages to be measured with the normal voltmeter leads. The 0020 is contained within and derives its power supply voltages from the DVM. The guarded input characteristics of the Dana DVM are retained for AC measurements. Full resolution of the DVM is available for AC measurements including the 1 volt full scale range.

SPECIFICATIONS

Model 0020 - Dana AC Converter

Function	Converts AC voltage into proportional DC voltages, which are measured by the DVM; all specifications refer to output of DVM as a function of AC voltage input
Frequency Range	10 cps to 50,000 cps
Voltage Range	500 volts RMS or 750 volts peak; 10 cps to 2.5 KC; 125 volts RMS or 180 volts peak; 2.5 KC to 10 KC.
Full Scale Ranges	1; 10; 100; 1000 volts full scale
Calibration	RMS for sine wave input; 1.11 times full wave average magnitude for other wave forms
Dana Certification	Sine wave
Certified Accuracy	50 cps - 1000 cps; 0.1% of reading or 0.02% of full scale of range, whichever is greater; 1000 - 10,000 cps; 0.2% of reading or 0.03% of full scale of range, whichever is greater
Typical Accuracy	10 - 50 cps: 1% of reading or 0.2% of full scale of range, whichever is greater; 10 KC - 50 KC: 1% of reading or 0.1% of full scale of range, whichever is greater
Range Control	Automatic with manual override selected by knob on DVM front panel
Decimal Point Indication	Automatic
Measuring Time	DVM DC measuring time plus two seconds without range change; five seconds worst case with automatic range selection

Input Impedance	1 and 10 VFS ranges: 1 meg with less than 150 pfd shunt; 100 and 1000 VFS ranges: 5 meg with less than 130 pfd shunt. (exclusive of external input cable)
Isolation	AC input is isolated and guarded from ground, the AC power line, electrical output
Size and Mounting	AC converter is enclosed entirely within Dana Series 4000/5000 DVM (5 1/4" high EIA rack); there are no additional cables, connectors, or controls
Card Location	Address 24
Color Code	Red/Yellow

DESCRIPTION

The Model 0020 AC Converter is an all solid state circuit card that accepts an AC signal and converts it to a DC voltage which is measured by the DVM. When used in a Dana Series 4000 or 5000, highly precise AC measuring capability is provided with automatic range selection.

The converter is essentially an AC amplifier with precise gain followed by a full wave rectifier and a low pass filter.

The converter senses the average value of the waveform and scales the output to indicate the RMS value of a sine wave.

Because the converter must present a stable and precise DC output, the output is well filtered; the time constant of the converter is a result of this filtering.

OPERATION

When the Model 0020 is installed in a Dana DVM, full AC measuring capability is available using the normal input leads. Basically, operation of the DVM for AC measurements is the same as for DC measurements, since the normal guarded input circuit is utilized, and all automatic features are available.

Referring to Figure 5.1 of the basic DVM manual, the Function switch is placed in "AC Volts". The Range switch may be either on one of the manually selected ranges or in "Auto".

Some care should be taken to select the correct Mode position. For most measurements, the "Tracking Auto Threshold" mode should be used. This allows the DVM to track any significant change in voltage with new readings as often as 5 times per second.

When the "Tracking Auto Threshold" mode is used and a range change occurs, an internal delay allows the filter to settle to full accuracy before a new reading is taken.

If the "Command" mode is used, care must be taken that the filter has settled before a reading is taken. The input must be connected for at least two seconds before a command is given, if full accuracy is to be realized. The

"Command" mode may be used with automatic ranging since the internal delay prevents a reading from being taken until a fully accurate measurement can be made. Range changes, of course, increase the time to make a reading.

STANDARDS LABORATORY CALIBRATION PROCEDURE FOR DANA AC CONVERTER, MODEL 0020

Equipment Required:

AC signal source, 50 cps to 10 kc, 0-500.00 volts RMS ± 0.03% with distortion of less than 0.03%.

Dana DVM Extender Card assembly part #400035 and converter input extender cable, (supplied with extender kit part #400913).

1.0 With the DVM power OFF, insert the converter with extender card, support bracket, and extender cable into the DVM. The door should be braced far enough open to keep it from shorting against the back of the extended unit.

1.1 Turn the power on and allow the voltmeter to warm up 10-20 minutes.

2.0 DC BALANCE

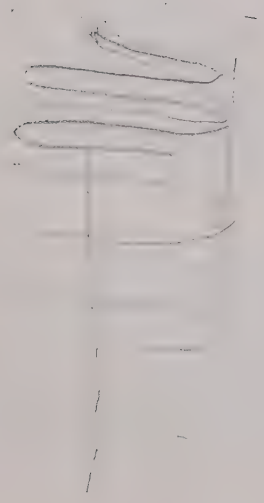
2.1 Place the Function switch to AC volts, "Range" to 10, and "Mode" to "Periodic".

2.2 SET IN 100 DIGITS TO INPUT ON 10 VOLT RANGE (4000's) ~~Short the "Volts Common" and the "Volts Input" leads~~, with the remaining leads left unconnected. Adjust R1 (Figure 2) CCW until a reading ~~is~~ observed on the meter. ~~Reverse the adjustment (CW) to the point where the reading disappears.~~

Set the instrument to the 1 volt range. On the 5 digit DVM's, the reading should be 20 digits or less. This is normal AC standoff. The same requirement applies to the other two range positions. On 4-digit instruments, if the 1.0 volt range reads more than two digits, continue turning the balance CW until the reading is one digit. This reading should not vary over short periods more than a single digit.

3.0 AC Calibration

For optimum performance, the following procedure should be followed in the exact order described. Many adjustments are interacting and, if the order is changed, it will be impossible to complete the calibration. For all of the following steps, the meter should be connected to



the AC source as in Figure 1.

3.1 10 Volt Range

3.1.1 Place the "Range Selector" to "10", apply 400 cps at 9.0000 ± 0.0027 volts RMS to the meter. Retain this voltage level for each frequency called for in the 10 volt range.

3.1.2 Adjust R2 (Figure 2) for a readout of 9.0000 on the meter.

3.1.3 Apply 10 KC and adjust C1 (Figure 2) for a readout of 9.0000 also.

3.1.4 Repeat 3.1.1, 3.1.2, and 3.1.3 to assure proper balance between the two adjustments.

3.1.5 Apply 50 cps, 3 KC, 5 KC, and 8 KC and observe readouts to varify response.

3.2 1.0 Volt Range

3.2.1 Place the "Range" selector to 1 and set the frequency to 400 cps at 0.90000 ± 0.0027 volts RMS. Retain the voltage level for each frequency in the 1.0 volt range.

3.2.2 Adjust R3 (Figure 2) for a readout of .90000.

3.2.3 Set frequency to 10 KC and adjust C2 (Figure 2) for a readout of .90000.

3.2.4 Repeat 3.2.1, 3.2.2, and 3.2.3 for a proper balance between the two adjustments.

3.2.5 Apply 50 cps, 3 KC, 5 KC, and 8 KC and observe readouts to varify proper response.

3.3 100 Volt Range

3.3.1 Switch "Range" to "100" and set the frequency generator to 400 cps. For the first adjustment, the input level will remain at 0.90000 volts RMS.

3.3.2 Jumper TP1 and TP 2 (Figure 2) and observe the readout. Change the input frequency to 10 KC. Adjust C3 to achieve the same reading as observed at 400 cps. Repeat the step to assure balance. Remove the jumper.

3.3.3 Set the input to 400 cps 90.000 ± 0.027 volts RMS. This voltage level should be kept throughout the rest of the 100 volt range adjustments.

3.3.4 Adjust R4 for a readout of 90.000.

3.3.5 Change the input frequency to 10 KC and adjust C4 for a readout of 90.000.

3.3.6 Change the input frequency to 5 KC. Adjust C5 to read 90.000.

Because of the interaction between C4 and C5, paragraphs 3.3.5 and 3.3.6 may have to be repeated several times before both readings balance. To keep calibration time to a minimum, after C4 has been adjusted to read 90.000 and the input set to 5 KC, observe the readout. Determine the number of digits difference between this value and 90.000. Adjust C5 to twice this number of digits past 90.000 and then readjust C4 to 90.000 at 10 KC. Repeat this, if necessary, to achieve a balance.

3.3.7 Apply 50 cps, 3 KC, and 8 KC and observe the readouts to varify proper response.

3.4 1000 Volt Range

3.4.1 Set the input to 10 KC at 125.00 ± 0.037 volts RMS.

3.4.2 Adjust C6 for a readout of 125.00.

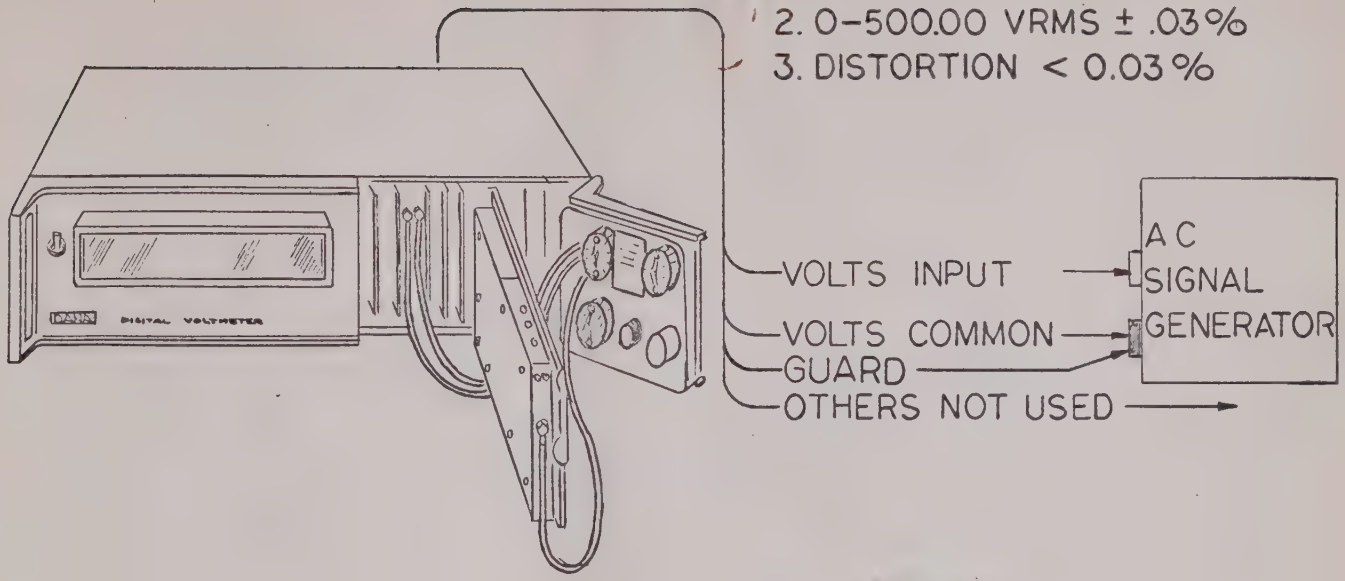
3.4.3 Set the frequency to 50 cps, 3 KC, 5 KC, and 8 KC and observe the readouts. These readings are dependent on the proper adjustments of the first three ranges and if C6 fails to bring the instrument within the specified tolerance on the 1000 volt range, the lower ranges will require readjustment.

3.4.4 If the converter is ~~badly~~ out of spec. where a large change in C6 is required, adjustment C3 may interact. The 100 volt calibration should be checked and readjusted if required. A check should be made between 100 and 1000 volt ranges although further adjustment should not be required.

3.5 Final Check

Because of the sensitivity of the AC Converter to stray capacitance, there may be some error at high frequencies in the two high ranges when the converter is inserted into the instrument. After the converter has been replaced into the DVM, observe the readout with the input set to 90.000 $\pm$ 0.027 volts and the frequency set to 10 KC. Record the reading and replace the converter on its extender card. With the input remaining at 90.000 volts and 10KC, adjust C4 to read 90.000 plus or minus the difference in the two readings(reading with card on extender and reading installed). If the readout was in the negative direction, set C4 to read the same amount in the positive direction and visa versa. When the converter is reinstalled in the instrument, the error should be corrected.

1. 50 CPS TO 10 KC
2. 0–500.00 VRMS ± .03%
3. DISTORTION < 0.03%



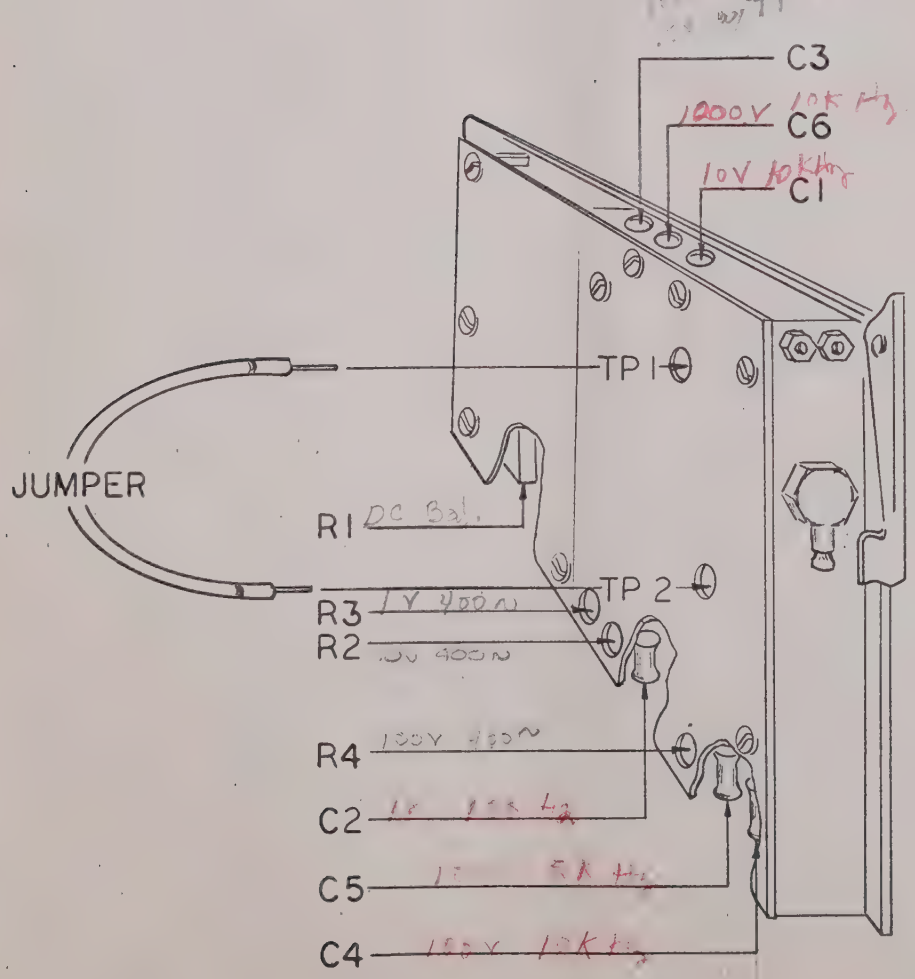


FIGURE - 2

INSTRUCTIONS

FOR

INPUT FILTERS

MODEL 0004
&
MODEL 0005

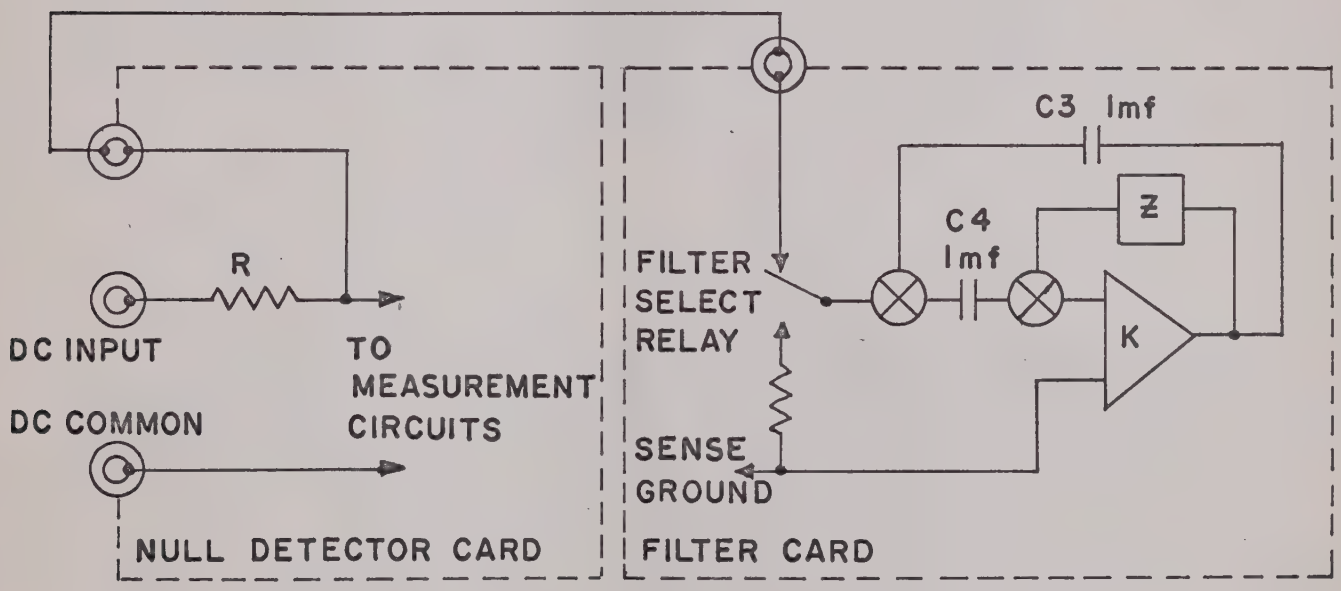
INTRODUCTION

The Models 0004 and 0005 are input filters designed for use with Dana Series 4000 and 5000 Digital Voltmeters respectively. When installed in a DVM which is properly wired, these filters allow precise DC voltage measurements to be made in the presence of line frequency hum or other superimposed AC signals. Except for balance time, the operation of the digital voltmeter is not disturbed by the filter.

DESCRIPTION

The Models 0004 and 0005 Input Filters are all solid-state cards designed for use with Dana Series 4000 and 5000 Digital Voltmeters respectively. The two cards are nearly identical and vary only in the value of several feedback components. A single schematic diagram (see accessory schematic section) with a table of values for these components supports both models.

Functionally, the filter is a simple operational amplifier connected as a capacitance multiplier. This circuit is combined with the input resistor of the null detector card to form a single section RC filter. A simplified block diagram of the filter is shown below.



If it were not for the feedback network "Z", the overall response would be that of a single section RC filter with the effective value of C, a function of K times C. "Z" establishes the response of the amplifier, thus, the rejection characteristics of the filter. The actual characteristics vary somewhat between the 4 and 5 digit cards; however, both have a notch filter in their feedback networks for maximum rejection at 60 cps. Complete specifications are provided on the following page.

SPECIFICATIONS

	Model 0004	Model 0005
AC Rejection, 60 cps	At least 70 db	At least 60 db
AC Rejection, 60 cps to 10 KC	At least 60 db	At least 40 db
Maximum source impedance (for 1 second setting time to 0.01%)	1000 ohms	300 ohms
Maximum Interference Signal	20 Volts, peak to peak	10 Volts, peak to peak

Circuitwise, Q1 serves as a logical inverter. Q3 drives the filter in/out relay and Q2 serves as a switch connecting C2 to the "timeout" circuit in the basic DVM, increasing ranging and polarity delays to approximately one second. The balance of the transistors, Q4 through Q11 are part of the basic operational amplifier.

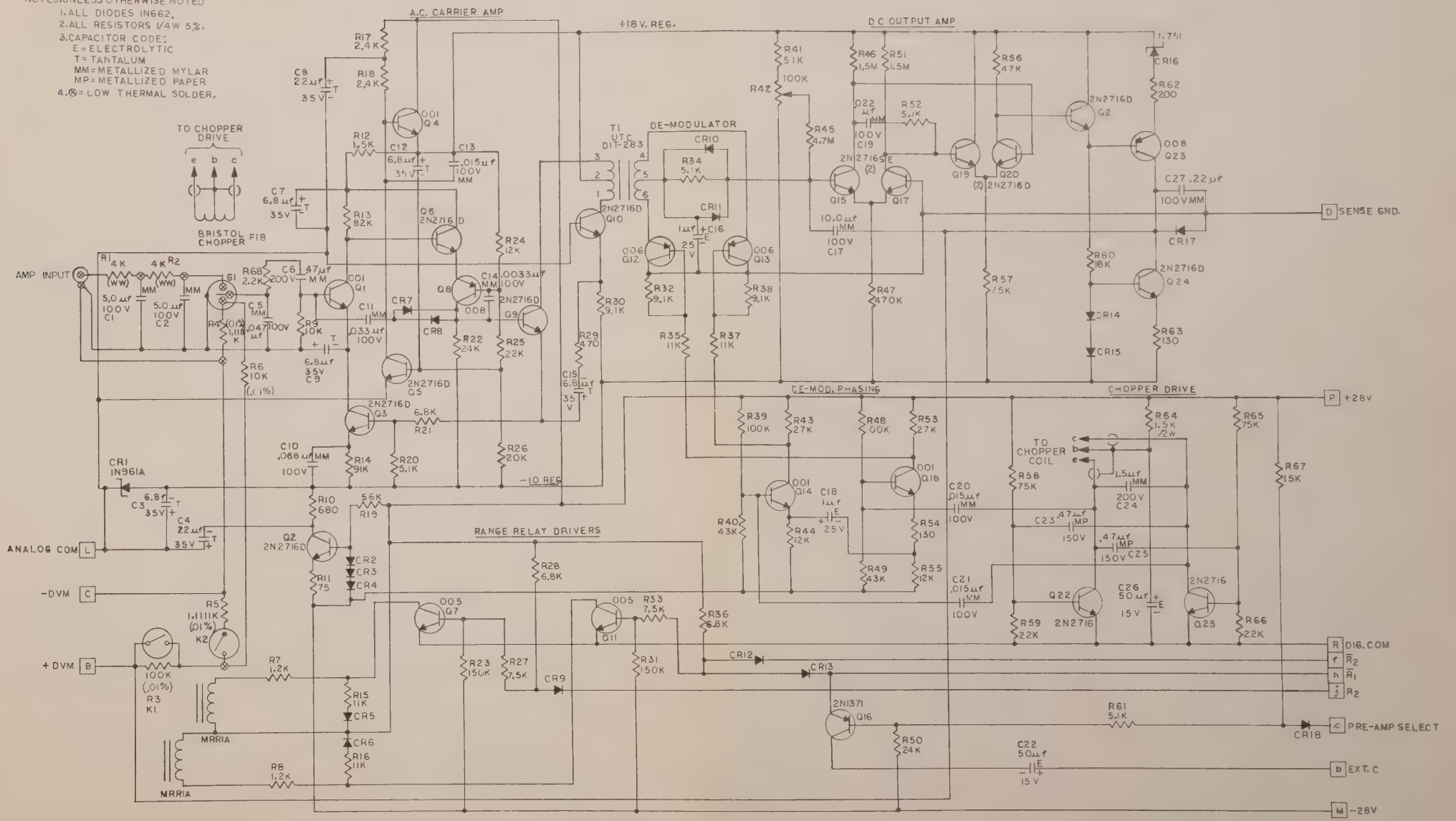
OPERATION

When the filter is properly installed in a late model DVM, it is activated by a "push-pull" switch connected to the shaft of the Threshold control. Early DVM's can be factory modified to provide this control.

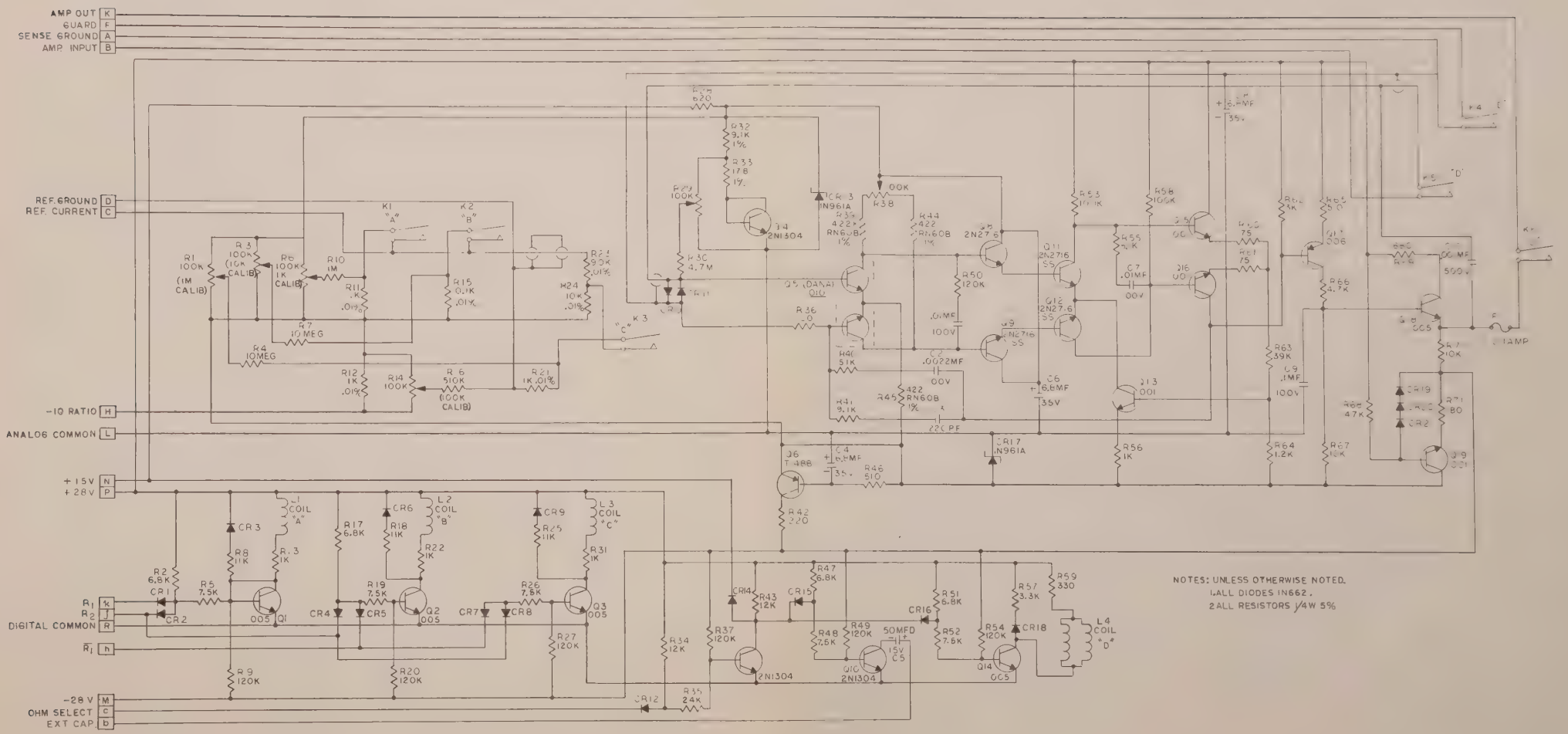
Installation in all current voltmeters is accomplished by slipping the filter card into the proper slot (see Page 3.4 of the basic DVM manual), seating it firmly and attaching the color-coded coaxial jumper between the null detector and filter.

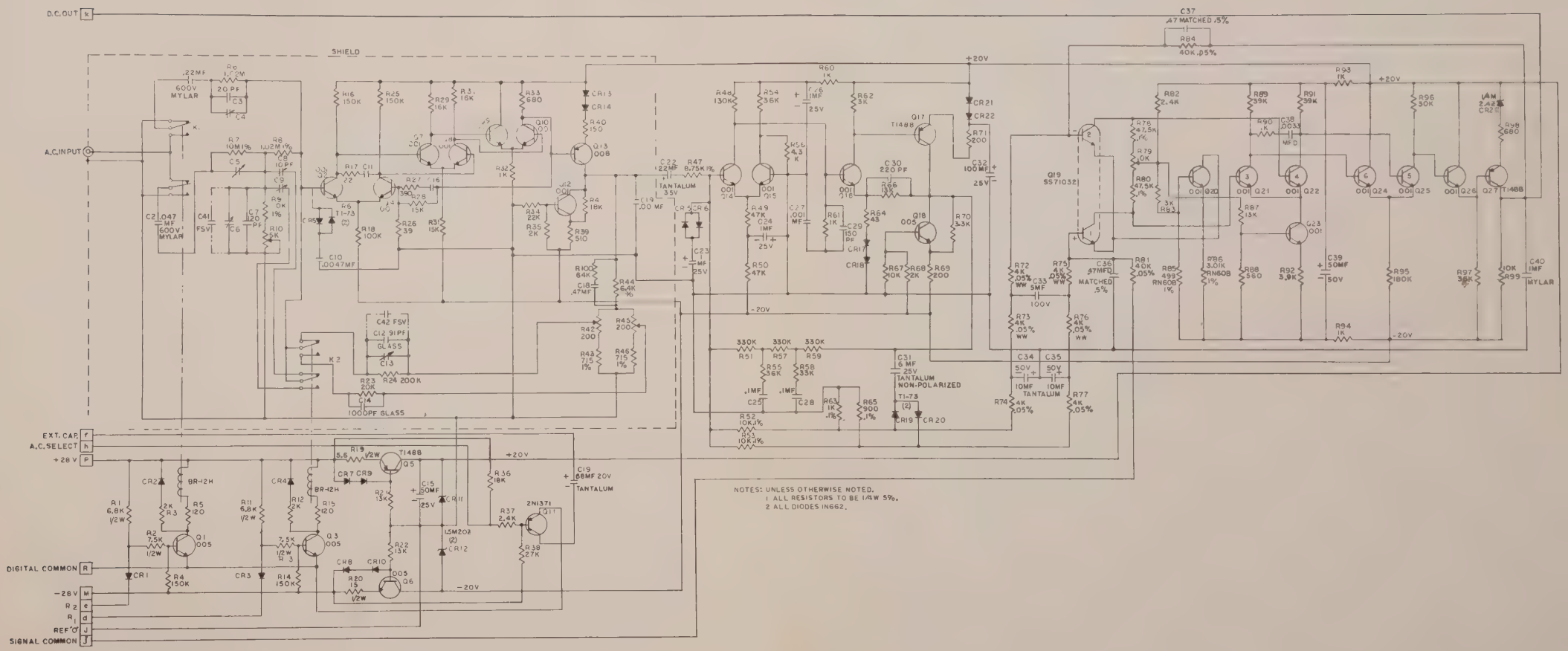
When using the filter, time must be allowed after each input change for the filter to settle to the new value (approximately one second). If automatic range or polarity changes are required, this additional time is automatically provided by increasing the period of the internal "time out" circuit. If no range or polarity changes are involved, the operator must wait until the reading becomes stable; or, in the "Command" Mode, insure that a Read Command is initiated <u>after</u> the filter has had sufficient time to settle.

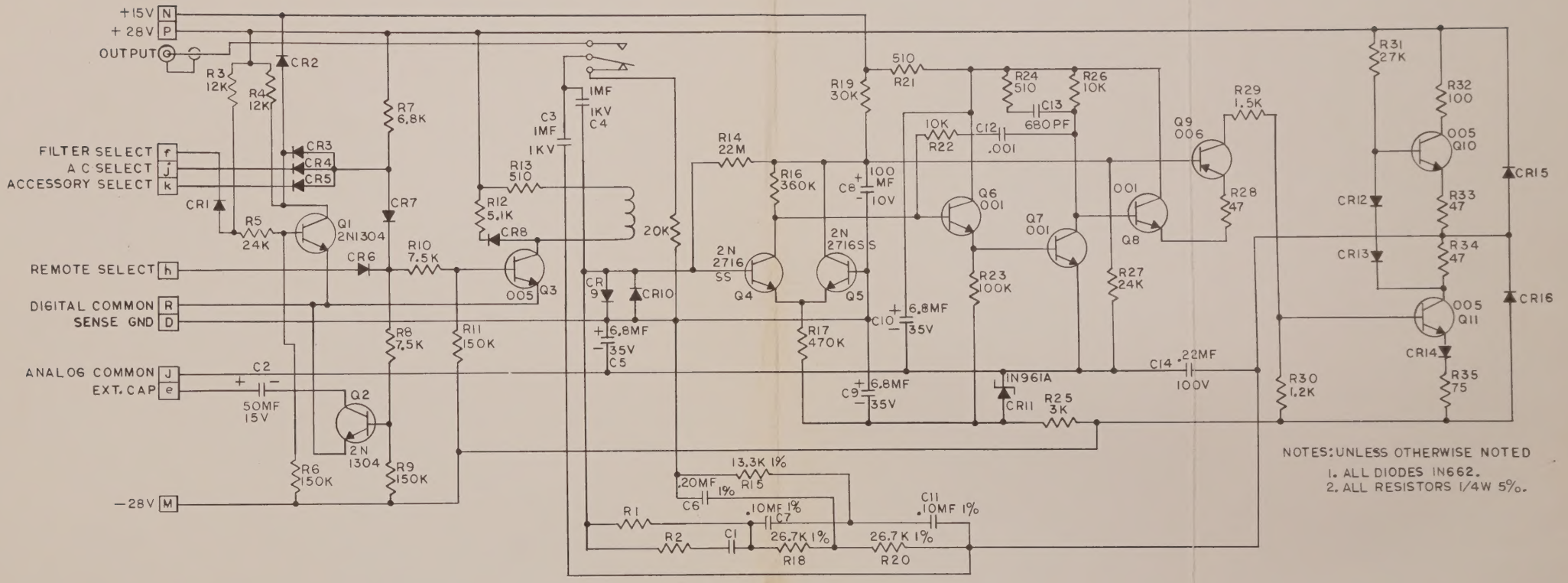
The filter switch may be physically pulled at any time; however, if the mode switch is on "AC", the filter is automatically inhibited as the AC Converter has its own filter and additional filtering is not desirable.



Model 0001
Preamplifier


AMP OUT K
GUARD F
SENSE GROUND A
AMP. INPUT B
REF. GROUND D
REF. CURRENT C
-10 RATIO H
ANALOG COMMON L
+15V N
+28V P
R1 k
R2 j
DIGITAL COMMON R
R1 h
-28V M
OHM SELECT C
EXT CAP b
NOTES: UNLESS OTHERWISE NOTED.
1.ALL DIODES IN662.
2.ALL RESISTORS 1/4W 5%


D.C. OUT
A.C. INPUT
EXT. CAP
A.C. SELECT
+28 V
DIGITAL COMMON
-28 V
R 2
R 1
REF 0
SIGNAL COMMON
SHIELD
+20V
-20V
NOTES: UNLESS OTHERWISE NOTED.
1 ALL RESISTORS TO BE 1/4W 5%.
2 ALL DIODES IN662.



	4 DIGIT	5 DIGIT
R1	3.9MEG	10MEG
R2	390K	0
C1	.047MF 100V	.022MF 100V

NOTES: UNLESS OTHERWISE NOTED
1. ALL DIODES IN662.
2. ALL RESISTORS 1/4W 5%.

Models 0004/0005
Input Filters

RECEIVED
FEB 8 1964
METROLOGY

RECEIVED
FEB 28 1964
METROLOGY

MP MASTER
MA31060